THE SENSITIVITY OF ANEMOMETER CUPS

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INTRODUCTION

The question as to which type of anemometer cup should be universally accepted as the standard type cup has long been disputed by those interested in the question. At the present time the organizations interested in questions involving the use of anemometers employ varied types of anemometer cups on their instruments and frequently change to a different type in the hope of obtaining better results.

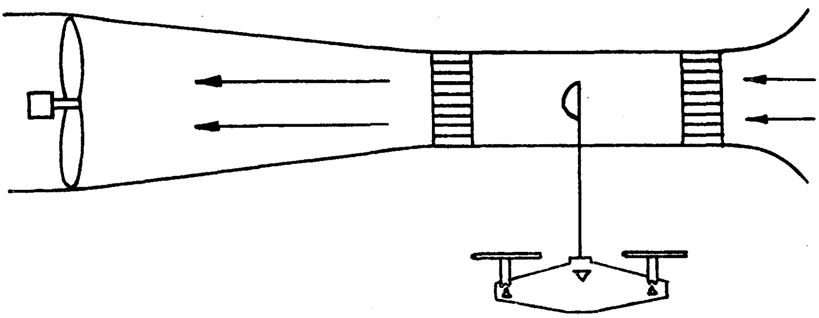

Fig. 1. Sketch of Wind Tunnel.

Studies have been made by various investigators as to the comparison of different type of cups best suited for their individual needs, but little has been done to compare the relative merits and disadvantages of various types of cups from comparable points of view.

It has been, therefore, the object of this investigation to study and determine the points of similarity and contrast of various cup shapes and to arrive at some conclusion as to the best cup shape or shapes which will give the maximum sensitivity in an anemometer.

APPARATUS

The apparatus used consisted of two parts, namely, a wind tunnel and the various cup shapes themselves. The wind tunnel used was of sufficient size to accommodate the cup shapes and was of such construction that accurate control of the wind velocity could be maintained. A sketch of the wind tunnel and the cup shape when in position is illustrated diagrammatically in Figure 1.

The wind velocity created inside of the tunnel was measured by a pitot tube pressure gauge which had previously been completely calibrated against a vane type anemometer. The force on the specimen was measured by means of an aerodynamic balance similar in construction to a laboratory platform balance.

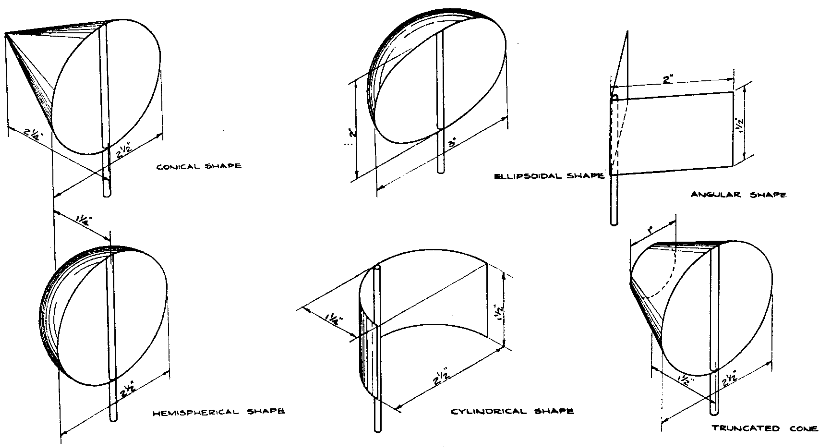

Fig. 2. Anemometer Cup Shapes.

The apparatus which was tested consisted of seventeen different cups comprising six general forms. The shapes tested were as follows: (1) angular shaped cups bent at angles of 15°, 30°, 45°, etc., ranging from 15° to the 180° straight angle; (2) truncated conical shape; (3) regular conical shape; (4) hemispherical shape; (5) ellipsoidal shape; and (6) cylindrical shaped cups. Diagrams of the various shapes with dimensions are shown in Figure 2. Each of the cup shapes was mounted on an arm and placed in position inside of the wind tunnel as indicated in Figure 1.

PROCEDURE

After the cup shapes had been mounted in position, the wind tunnel was turned on and data recorded of both the wind velocity and the corresponding force on the sample. Readings of the wind velocity were taken on the pressure gauge at appropriate steps from zero wind velocity to the capacity of the wind tunnel, which was 16.23 miles per hour velocity. The corresponding forces were measured on the aerodynamic balance.

The cups were completely tested in one direction and then turned around 180°, so that the other side of the cup faced the wind flow. Complete readings were again taken. The force against the cup and force with the cup mean the force produced when the wind blows against the interior of the cup and the force produced against the exterior of the cup respectively as illustrated in Figure 3.

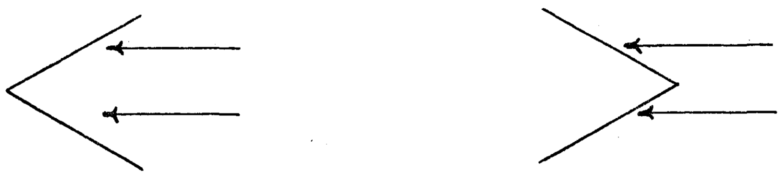

Fig. 3. Wind Forces against the cup (left) and with the cup (right).

Plots were then made to show the relationship between the force and the wind velocity in each case. Sample sets of curves are represented in Figures 4 to 8. In these graphs, the circular figures pertain to the values of the force against the cup, while the solid dots represent the values of the force with the cup.

RESULTS

On the basis of the results presented in the curves, it is possible to arrive at a conclusion as to the most sensitive cup tested. Following the line of reasoning that the force against the cup would be greater than the force with the cup at the same wind velocity in order for the cup system of an anemometer to rotate, it becomes evident that the cup which exhibits the greatest difference in force on the front and on the back of the cup (or force against and force with the cup respectively) for the same wind velocity would be the most sensitive cup.

TABLE I

Force Differences

Cup Shape	0–8 miles/hour	8–12 miles/hour	12–16 miles/hour
Ellipsoid	3.3	9.2	15.1
Cone	2.5	6.5	11.8
Hemisphere	2.4	7.7	14.9
105° Angle	3.2	6.5	8.4
90° Angle	2.9	6.0	11.3

For the purpose of comparison of the cups, the region for the wind velocity was divided into three parts, namely, that region representing 0 to 8 miles per hour velocity, that representing 8 to 12 miles per hour, and that representing 12 to 16 miles per hour velocity. The corresponding values for the differences in force were then recorded. Such data are presented in Table I.

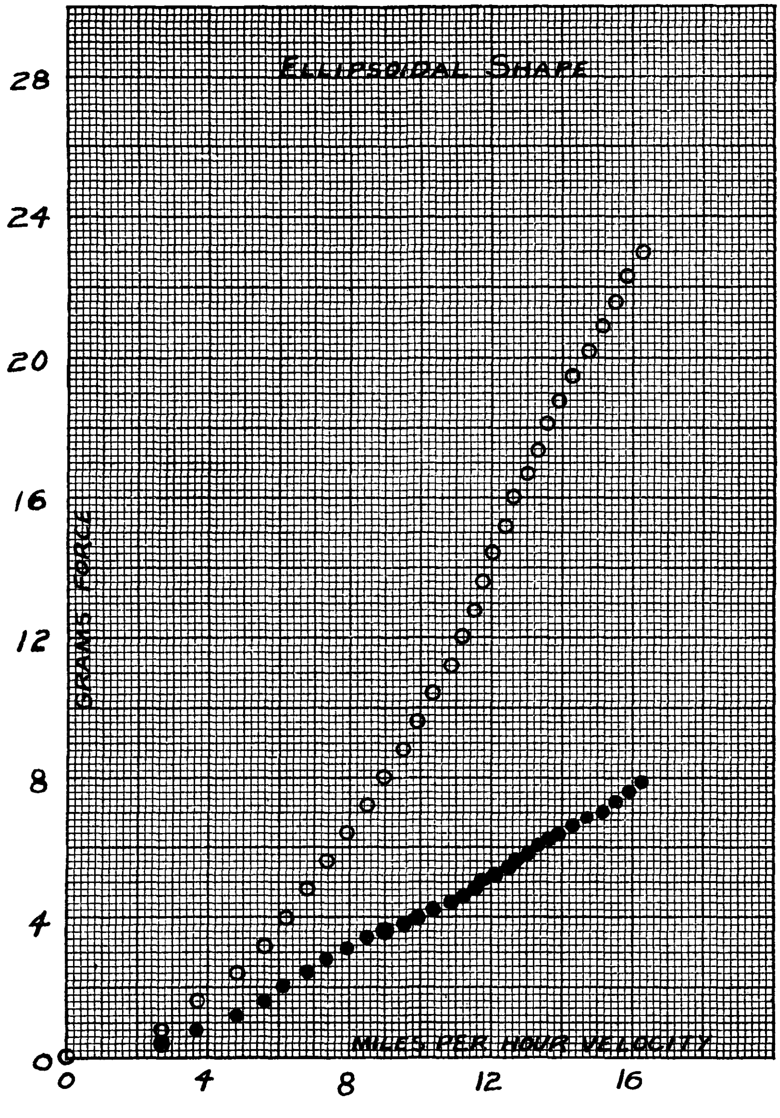

Fig. 4. Relation between force and wind velocity with ellipsoidal cup.

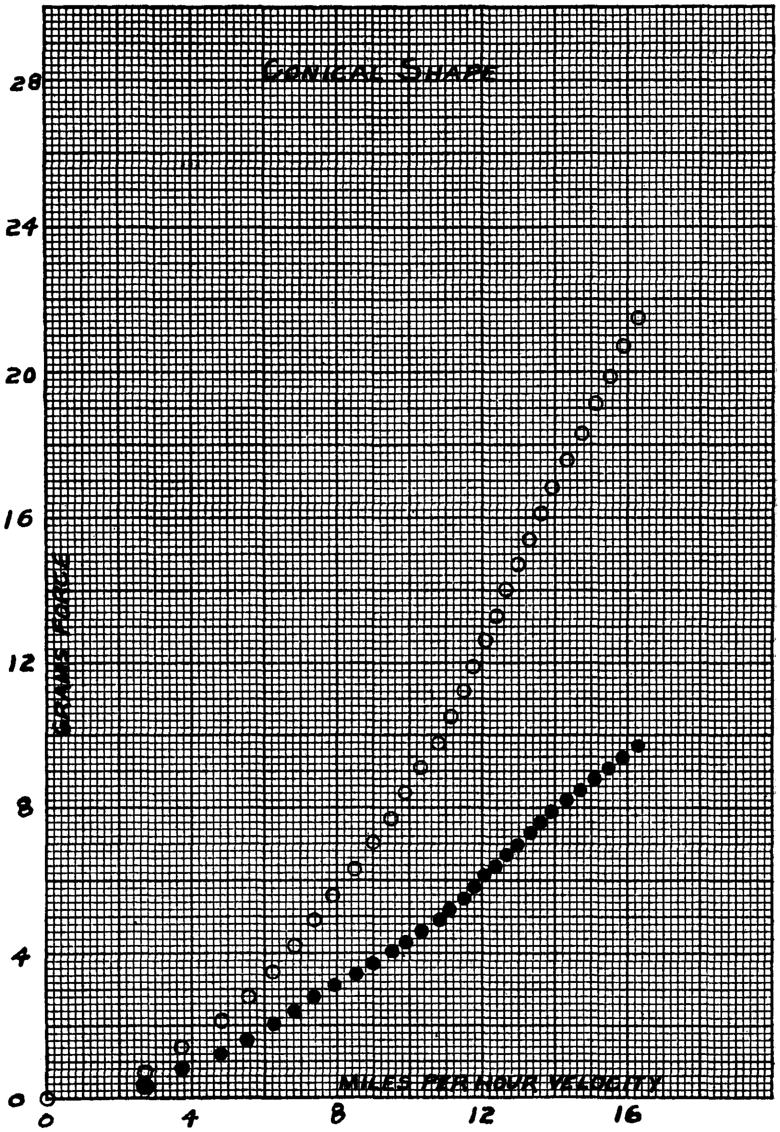

Fig. 5. Relation between force and wind velocity with conical cup.

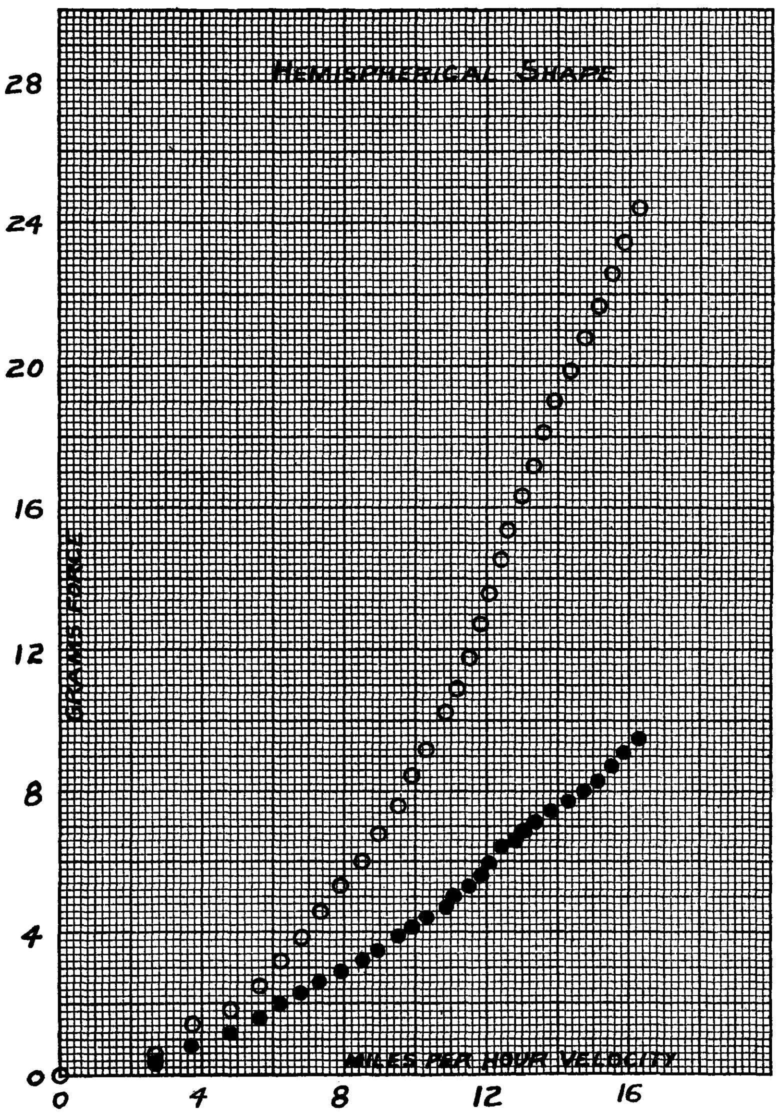

Fig. 6. Relation between force and wind velocity with hemispherical cup.

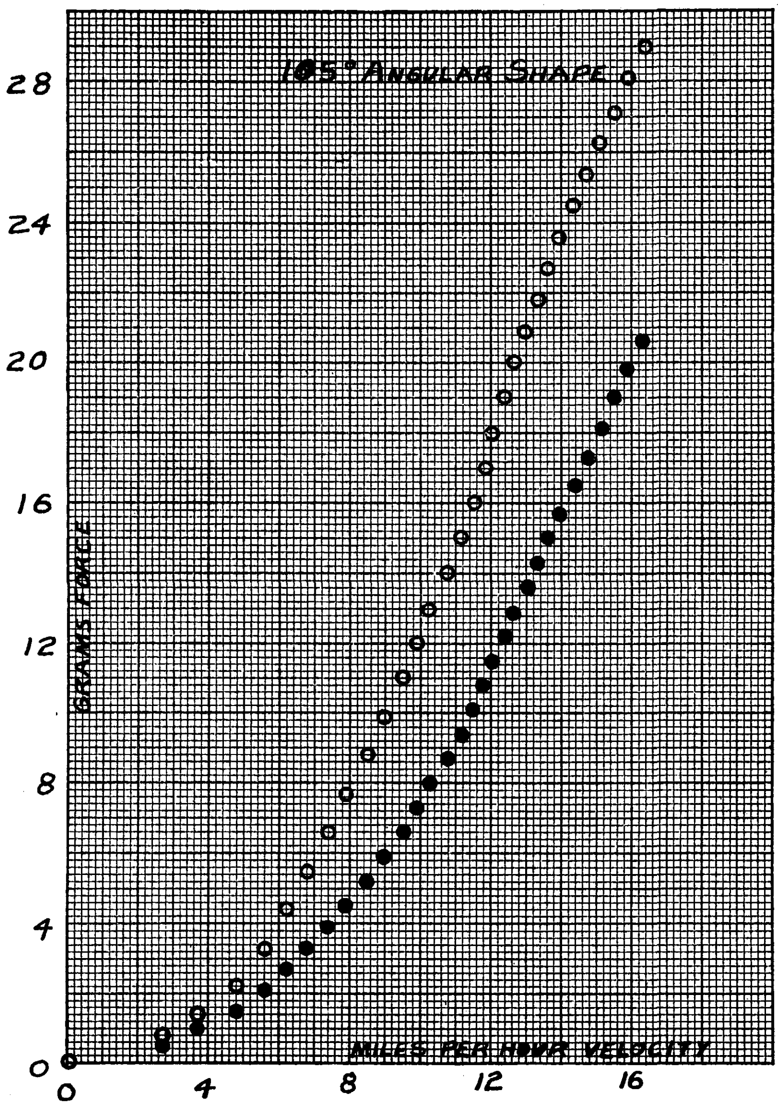

Fig. 7. Relation between force and wind velocity with 105° angular cup.

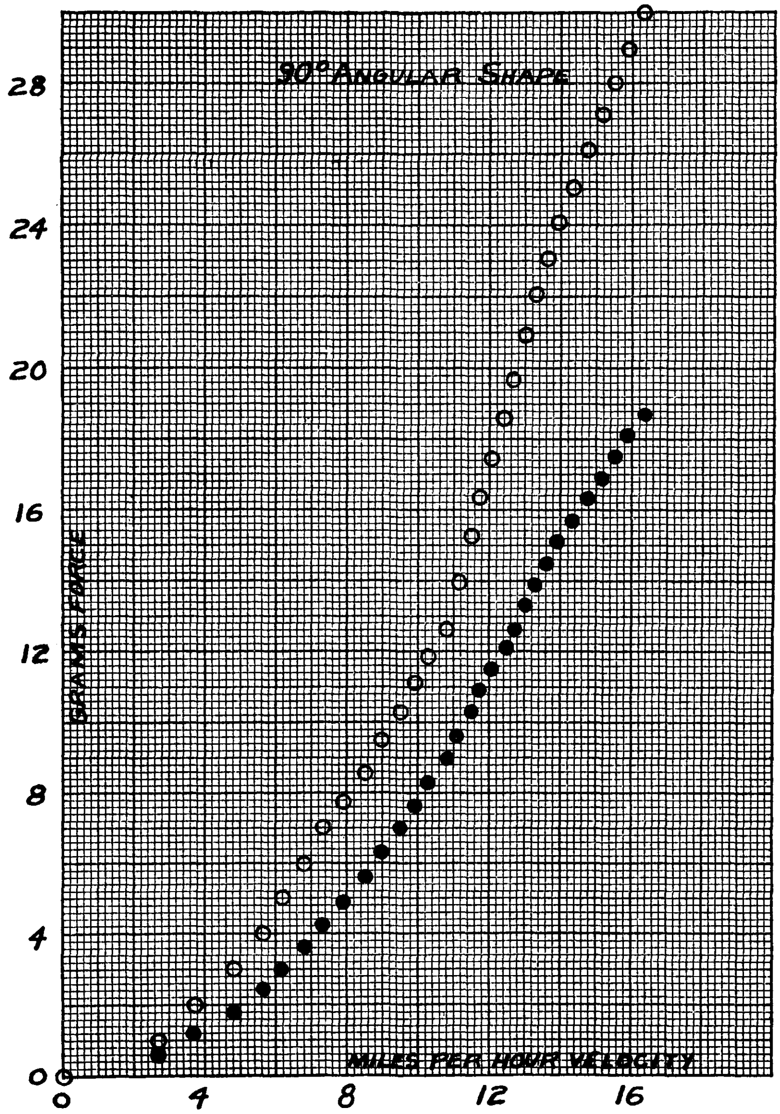

Fig. 8. Relation between force and wind velocity with 90° angular cup.

SUMMARY

From the results obtained, the conclusions of this investigation may, therefore, be summarized as follows:

(1) The ellipsoidal shaped cup is the most sensitive over the entire range tested.

(2) The conical shaped cup is fairly sensitive in both the lower and middle regions.

(3) The hemispherically shaped cup is fairly sensitive over the entire range, being only slightly less sensitive than the ellipsoidal shaped cup.

(4) The 105° angular shaped cup is very sensitive in the lowest region and fairly sensitive in the middle region.

(5) The 90° angular shaped cup is fairly sensitive over the entire region.

The entire procedure was then repeated with beaded cups. These cups were identical with those previously described with the addition of a slight beading along the outer edges. The results obtained from the testing of these shapes shows that the sensitivity of an anemometer cup is not improved by adding a bead to the cup.

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